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DIABETIC RETINOPATHY DETECTION USING DEEP LEARNING

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Abstract - Diabetic retinopathy is a disease caused by uncontrolled chronic diabetes that can result in total blindness if not diagnosed early. To avoid the severe side effects of diabetic retinopathy, the leading cause of blindness among working-age adults, early medical diagnosis and treatment are essential. We hope to detect and prevent this disease in rural areas where medical screening is difficult to conduct. Currently, technicians travel to these rural areas to capture images, which are then reviewed and diagnosed by highly trained doctors. By using technology, they hope to scale their efforts and eventually be able to automatically detect disease in images and indicate how severe it might be. Building a Convolutional neural network model that can automatically assess the degree of blindness in a patient by looking at an image of their eye will help us achieve this. Automation has the potential to drastically cut treatment times for diabetic retinopathy on a large scale.

Keywords: *Diabetic Retinopathy, Artificial intelligence, Deep learning, Machine-learning, Dataset, CNN*

1. INTRODUCTION

Diabetic retinopathy (DR) is one of the most complicated issues of diabetic patients in which the retina becomes damaged and leads to blindness. It affects the blood vessels in the retina and due to leakage of fluid distort the vision completely. DR progresses through mainly four stages; the earliest stage is Mild no proliferative retinopathy, where only micro aneurysms can occur. The second stage is Moderate no proliferative retinopathy, where the blood vessels' lose their ability of blood transportation because of their distortion and swelling with the progress of this disease. The next stage is severe non-proliferative retinopathy, which results in deprived blood supply to the retina due to the increased blockage of more blood vessels signaling the retina for the growing of fresh blood vessels. The final stage is Proliferative diabetic retinopathy, which is an advanced stage , where the growth features secreted by the retina activate proliferation of the new blood vessels, growing along the inside covering of retina in some vitreous gel, filling the eye.Each and every stage has its own characteristics and particular properties. But doctors possibly could not take some of them into account and thus make an incorrect diagnosis. So this leads to the idea of creation of an automatic solution for DR detection. DR can lead to a loss of vision if it is in an advanced stage. Worldwide, DR Causes 2.6% of blindness. The possibility of DR presence increases for diabetes patients who suffer from the disease for a long period. Retina regular screening is essential for diabetes patients to diagnose and to treat DR at an early stage to avoid the risk of blindness. DR is detected by the appearance of different types of lesions on a retina image. These lesions are micro-aneurysms (MA), hemorrhages (HM), soft and hard exudates (EX). Micro aneurysms (MA) is the earliest sign of DR that appears as small red round dots on the retina due to the weakness of the vessel's walls. The size is less than 125 µm and there are sharp margins. Michael et al. classified MA into six types, as shown in Fig. 1.1. The types of MA were seen with AOSLO reflectance and conventional Fluorescence imaging.

2. LITERATURE REVIEW

1. The Diabetic Retinopathy (DR) level in humans is detected by scanning the human bodily structure image for the presence of hemorrhages and Exudates. The SVM classifier is trained with some bodily structure pictures showing the various layers of DR. when extracting the options, they'll go below classification half for distinguishing whether or not the provided input image is traditional or having DR. The input check image fed to the classifier fitly classifies the extent of DR supported the coaching of SVM Classifier[1]
2. In the authors have applied deep learning algorithms for automatic detection of diabetic retinopathy and detection of diabetic macular edema in retinal fundus photographs. The algorithm was developed using the Stats Models version 0.6.1 and SciPy version 0.15.1 python packages. The authors proposed a convolutional neural network that uses nearby pixels into local features, then aggregates those into global features. The proposed method is trained to recognize local features. The disadvantage is to determine the feasibility of applying the algorithm in clinical settings[2]
3. In multi-class SVM and KNN classifiers are applied to the images to determine the grade of abnormality. The authors have experimented on MESSIDOR, and Diabetic ret DB. The images are preprocessed and the optic disc is removed. Features for classification are extracted using GLCM[3]
4. The authors in propose a classification based method. In the proposed method after capturing the image from the optical camera, a Matched filter response is applied for removing the noise within the image. The image is preprocessed and Fuzzy c-means is applied to achieve a clear image of the blood vessels. That makes the blood vessels of the image clearly visible. Features such as radius, diameter, area, arc length, center Angle and 0.5 space area unit are computed. Features are classified

using Support Vector Machine and Probabilistic Neural Network for identifying NDR and DR.[4]

5. In proposed a data-driven method for DR classification. The algorithm processed color fundus images and classified them as having DR or NDR[5]

6. In the proposed method authors tend to analyze a collection of seventeen features such as textural contrast of the image, energy of the image, entropy of the image, homogeneity of the images, image area, major axis and axis length of the image, convexo-concave of the image. In the proposed method the authors used eleven features out of seventeen features by analysis of variance (analysis of variance between groups) for DR classification.[6]

7. In this paper a model ANN system has three layers, the principal layer has input somatic cell that sends information victimization the neuro-transmitters to the second neuron layer & subsequently employing a giant number of neural connections to the third layer of the output neurons. The additional difficult system can have neuron layers (3,4,5,6...) that have a large layer of input and output neuron layers like the input layer, hidden layers & the output layers (large number). The NN stores the features of the neurons such as the weight and which controls the info for different calculations used for the training purposes. The information presented in this paper is just the work done by various authors till date in a nutshell so that the researchers can know about the recent advances in the work done on glaucoma & its related items and can further refine their work with some additional information, define their own research problem looking into the drawbacks of the works of theexisting works[7]

3. PROBLEM STATEMENT

Diabetic retinopathy is one of the most threatening complications of diabetes that leads to permanent blindness if left untreated. One of the essential challenges is early detection, which is very important for treatment success. Unfortunately, the exact identification of the diabetic retinopathy stage is notoriously tricky and requires expert human interpretation of funds images. Simplification of the detection step is crucial and can help millions of people. Convolution neural networks (CNN) have been successfully applied in many adjacent subjects, and for diagnosis of diabetic retinopathy itself. However, the high cost of big labeled datasets, as well as inconsistency between different doctors, impedes the performance of these methods. In this paper, we propose an automatic deep-learning-based method for stage detection of diabetic retinopathy by single photography of the human fundus. Additionally, we propose the multistage approach to transfer learning, which makes use of similar datasets with different labeling. The presented method can be used as a screening method for early detection of diabetic retinopathy with sensitivity.

4. OBJECTIVES

The objectives of the system are

1. To detect blindness due to diabetes mellitus inthe early stage.
2. To make graphical representation on classes forage, sex, and occupation.

5. PROPOSED SYSTEM

CNN has been widely known for applications like image processing, pattern recognition, and video recognition. CNN in image classification takes a picture as the input and classifies it into a suitable class. It's a variety of hidden layers within which convolution is finished to extract features and alternative valuable data from the image. In R-CNN, the image is segmental into several regions (or segments) and also CNN is compelled to specialize in these segments. The accuracy of object detection is incredibly high compared to it CNN because of the extraction of interest. Fig. 2 represent the proposed system for the classification of DR and non DR fundus images.

A. Preprocessing

Initially, the first fundus pictures are resized to a dimension of 200 x 200.due to the huge data and ranging distinction of pictures obtained from the fundus cameras preprocessing is important. Without preprocessing the photographs suffer from igniting effects and image distortion. Since the photographs are obtained from totally different fundus cameras they'll be having non- uniform illumination. Illumination standardization techniques have to be compelled to be incorporated. The image consists of three channels Red, Green, and Blue. The Green channel is extracted for further processing. Green channel extraction: The extraction of the green channel provides a higher contrast between most and minimum intensities in a picture. It's less noise compared to that of red or blue Channels. Blue channel provides less contrast and doesn't contain a lot of data. Adaptive Histogram Equalization: This image processing technology improves the contrast of the image. It is usually performed in small regions of the image called tiles. This helps in enhancing the edges of the image

B. Optic disc removal

Automatic Optic Disc (OD) removal is an important step because of optic disc act as false positives as they greatly resemble exudates in intensity. Firstly Images are converted into grayscale whose intensity values range between 0 to 255 and then thresholding is done. The pixels having intensities lower than a certain threshold are converted to 0 (black), and the pixels having

intensities above the threshold are converted to 255 (white). The dilate-erode combinations are used, which eliminate unconnected small regions and preserves large unconnected regions. In segmentation structuring element used is a disk having size 30 and applied over the image. The process of thresholding is continuously updated and it is repeated until only one region remains.

C. Extraction of region proposals

Region of interest is extracted using two ways by means of thresholding and blocking (Pixel-based). Based on intensity variations the region of interests (i.e., those segments that contain lesions) are extracted. For any process solely these segments are thought-about. Threshold-based: The extraction of regions from the preprocessed image is achieved by thresholding the intensity values of red lesions and exudates on an individual basis.

The dataset for training can be obtained from IDRID (Indian Diabetic Retinopathy Image Dataset).In the proposed method, 4 layers for R-CNN are used, trained on 130 images and tested on 100 images. All the images were classified into two groups i.e., with DR and without DR. Fig. 5 represents the CNN architecture for the proposed method. The steps for the proposed method are summarized as follows:

Steps Of The Proposed Method

1. Select the Green channels of the retinal image
2. Extract the Optic Disc
3. Regions containing the DR lesions is extracted using a pixel-based approach discussed above
4. These lesion based pixels blocks are loaded as input to the Convolutional Neural Network (CNN).
5. The images containing DR lesions are pre-processed by normalizing. The image size is augmented to 200x200
6. Proposed CNN architecture consists of 4 dense layers having a 3x3 kernel size with a Max-Pooling layer of 2x2 in between and a dropout layer.
7. After the 4 dense layers, two layers are used to flatten the network and then classification id achieved using Softmax.
8. Cross entropy is used as the cost function and classification is achieved after 500 epochs.
9. The model is trained on 130 images and then tested on100.

7. SYSTEM ARCHITECTURE

The system consists of major steps preprocessing, feature extraction, and classification. In the testing phase verification is done with pertained sample signatures.

1. Dataset

This study used publicly available Kaggle Dataset for Diabetic Retinopathy Detection. The database was created with images taken from publicly available retinopathy detection datasets. The Kaggle dataset contain 1000 images with diabetic retinopathy and 1000 images without diabetic retinopathy. From the total images we have chosen 122 images with diabetic retinopathy and 122 normal images. Chosen abnormal images contains exudates, hemorhages, andmicroaneurysms.

2. Preprocessing

In image pre-processing, to find exudates, initially imagefrom dataset is converted to HSV image. Colour space conversion is converting an image that is represented in one colour space to another colour space, the goal beingto make the translated image look as similar as possibleto the original. Red, Blue, Green channels in the givenimage to Hue, Saturation, Value. It is useful to extractyellow coloured exudates from RGB image when we convert RGB to HSV. Then e
histogr

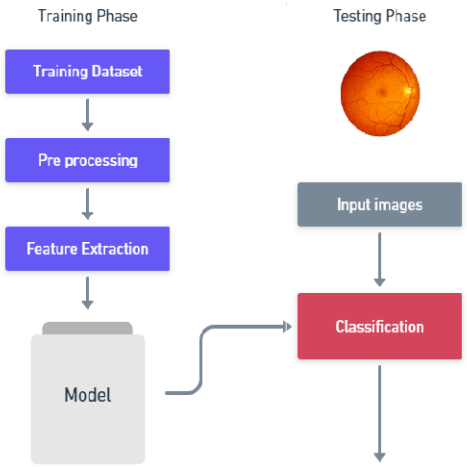

Fig. Block Diagram.

3. Feature Extraction

For binary classification, here we are using 2 features, ie,number of exudates as first parameter and number of hemorrhages and micro aneurysms as second parameter. That is, we are counting number of white pixels from the segmented images and divide it by total number of pixelsin the image.

4. Classification

In the proposed method we are implementing hybrid classifier. That is we are using combination of fiveclassifiers, Support vector machines, K nearest neighbours, Random forest. Each classifier will classify the total 244 images into either normal or abnormalimage. SVM classifier with kernel radial bias functionand degree 3 is used. After obtaining the classifiers wehave done voting as hybrid method. Training of dataset isdone on five different classifiers and testing is done.Training and testing set are prepared in ratio 80:20.

Software Requirements

1. Programming Language – Python
2. Libraries – NumPy, TensorFlow, Keras, OpenCV, Streamlit
3. Database – SQLite
4. Cloud – Azure/AWS
5. Tools – Visual Studio Code
6. Algorithm – CNN

8. APPLICATION AREAS

1. Diabetic Retinopathic Detection
2. Automatic Retinopathic Grading System
3. Classify optical coherence tomography

CONCLUSION

The goal of this proposed study is to demonstrate how biomedical image processing can aid in the early and non-invasive detection of DR. Complex and time-consuming human labour is decreased with the aid of simple and straightforward image processing techniques. Images of diabetic retinopathy or non-diabetic retinopathy can be found in fundus eye images. The patient can save time and money by not having to go to a physician or clinician for a diagnosis of DR. A fundus camera and a computer system with OpenCV installed are essentially all that is needed for this proposed method, which makes it a deep learning algorithm for detecting Diabetic Retinopathy early and preventing patients with DR from losing their vision permanently.

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